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ABSTRACT

The Diagnostic Testing System (DX) is an integral system for developing and administering tests. The system can be utilized for testing in any subject matter, or any number of subject matters, at any level on scholastic or cognitive continuums. The major purpose of DX is to provide diagnostic data about the level at which a given student (or group of students) comprehend the material or concept being tested. Based on a one-disk or two-disk configuration of the Apple II with 48k of memory, the DX prepares an interpretive, diagnostic readout for the instructor which includes a record of the performance as well as a short narrative explaining the level at which the respondent comprehends the material tested. The DX package of eight subprograms includes test writing and editing systems, a test outcome feedback system, and a system for determining how many and which tests will be administered at a given time. DX, in its entirety, is designed so as to present a technically simple package which can be easily learned and put into operation by classroom teachers, including those without computer know-how. (PN)

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DIAGNOSTIC TESTING SYSTEM: A COMPLETE DIAGNOSTIC MULTIPLE-CHOICE TEST PACKAGE FOR THE APPLE II

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Section I

Introduction

The Diagnostic Testing System (DX) is an integral system for developing and administering tests. The system can be utilized for testing in any subject matter, or any number of subject matters, at any level on scholastic or cognitive continuums. The major purpose of DX is to provide diagnostic about the level at which a given student (or group of students) comprehend the material or concept being tested.

Based on a one-disk or two-disk configuration of the Apple II (or Apple II+), with 48k of memory, the DX package is an interactive diagnostic system for multiple-choice testing. It will provide you with a way to enter files of multiple-choice questions, to make changes in the files, to examine existing records of performance, and to administer multiple-choice diagnostic tests by computer to individual students. Basically, as the respondent or student responds to a set of test items the DX system is recording the performance. Simultaneously, DX is preparing an interpretive, diagnostic readout for the instructor which includes a record of the performance as well as a short narrative explaining the level at which the respondent comprehends the material tested.

The DX package includes eight subprograms. These component programs include test item writing and editing systems, a test outcome feedback system, and a system for determining how many and which tests will be administered at a given time. DX, in its entirety, is designed so as to present a technically simple package which can be easily learned and put into operation by classroom teachers, including those with no computer know-how whatsoever. If you can type, you can use the DX package.

This manual is organized into eight sections, including this Introduction. The theoretical background which underlies the DX method is described in Section II. The manual covers various strategies for defining and putting into operationthe concept of "levels of comprehension" which DX is designed to assess. Section III delineates the lattice which is the basis for item sequencing in the DX test. It is on the basis of this item order that the program is eventually able to deliver a diagnostic assessment of pupil comprehension.

The fourth, fifth, and sixth sections acquaint the user with the software included in the DX package. In Section IV, each of the subprograms is described in detail. In Section V, the entire DX test development process is illustrated by reviewing an example test file (which is included in your program disk). Finally, Section VI provides hands-on, guided demonstration by which the user creates an original item set and test program based on the DX lattice foundation.

Section VII illustrates the nature of the feedback which the DX package produces, as well as procedures for interpreting and scoring DX outcomes. Test results are reported in three coordinated, simultaneous statements which provide the instructor with information concerning each respondent's performance on the DX test. Thesedata can be analyzed either by traditional methods of number of correct responses, or by level of comprehension as described in Sections II and III. The final section (VIII) provides concluding remarks for the manual.

Section II

Theoretical Background

Recent research by Weiss and others has shown that the use of computer managed adaptive testing can be linked effectively and efficiently with item response theory. The increasing availability of small computers makes the use of sophisticated models of objective measurement based on the interaction of individual examinees with single items feasible in a wide variety of training and testing applications. At the Center for the Study of Evaluation, University of California, Los Angeles, we have been investigating the advantages of computer prompted interactive testing with the specific intent of analyzing and diagnosing patterns of errors.

The first volume of Journal of Educational Research contained a study of diagnosis of error types (Willing, 1920); the first volume of Journal of General Psychology contained a major article by Spearman (1928) on the "Origin of error"; the second volume of the British Journal of Educational Psychology presented a lengthy analysis of theories of cognitive error (Fortes, 1932). Despite the intervening years, the concepts about error initiated in those articles hold up surprisingly well. Errors tend to show themselves as matters of either principle (such as faulty reasoning, misunderstanding, or inability to apply a correct method or strategy) or accuracy (such as errors in copying, manipulating numbers, or misplacing parts of the problem).

The Tatsuokas have been studying a complex series of erroneous rules of operation specific to the task of substraction. Other researchers, using latent trait models (Samejima, Wright, and Lord, for example), have

treated incorrect responses on a test as stemming in part from chance. We believe that there are a number of important diagnostic hypotheses about patterns of error relating to the specific individual being tested. These have to do with the student's ability to determine the correct answer before prompting or after either direct or indirect prompting. Learning of the initial concept might have failed for the student; the underlying conceptual grasp may be faulty; or, on the other hand, a short detour through less difficult material may allow the student to succeed on retry with a more difficult higher order question. For these hypotheses it is appropriate to collect detailed evidence by further prompts from the same item, by "decompressing" or "dismantling" the item in obtaining parallel responses to its component parts, or by administering one or more parallel items. Evidence from a finite number of different items or of components of decompressed items, gathered on the same individual, is needed to establish the credibility of each hypothesis. Such credibility is necessary in either of two circumstances--development of detailed diagnostic reports concerning students and in automatic modification of the testing and instructional program.

For a test of reasonable length, the number of possible sets of hypotheses that could explain a particular response pattern would be astronomical. However, by planning that the testing procedure will remain within a specific pool of items, we can limit the number of sets to be processing capacity of the computer, allows the scanning of response patterns in order to determine "likely" hypotheses <u>during</u> the adaptive testing session itself.

There are several views about the issue of levels within multiple-choice testing. One widely regarded approach stems from work

conducted by Benjamin Bloom and colleagues during the 1950's (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). Recent work by a number of researchers has re-examined the concepts of "taxonomy" of skills of thinking. (The interested reader is referred to Carroll, 1978, for a review of seven separate approaches to this problem.) Two books have been recently written on the tasks of writing good items for multiple-choice testing; one is the easily readable book by Miller, Williams, & Haladyna, 1978: Beyond Facts: Objective Ways to Measure Thinking. The more thorough of the two is the most recent contribution to this area, A Technology for Test-Item Writing by Roid & Haladyna (1982).

Williams and Haladyna have developed a three-dimensional model for classifying objectives. The first two dimensions in their scheme are already accounted for by the very nature of the DX testing system: Response Mode (selected vs. constructed) and Content (facts vs. concepts vs. principles). The third dimension of their model provides an extremely useful and operationalized taxonomy of levels for cognitive tasks. Those levels are as follows (Roid & Haladyna, 1982, pg. 165-166):

1. Reiteration is a task which requires the student to recognize or produce information in essentially the same form in which it was presented.
2. Summarization requires the student to recall the substance of the information without a verbatim requirement.
3. Illustration requires the student to show comprehension by recognizing or constructing illustrative examples based on material not contained in the source message.

4. Prediction. Using principles or rules derived or inferred from the message meaterial, the student predicts outcomes given previously unmentioned or unencountered situations.
5. Evaluation involves decison making based on the use of some criteria.
6. Application. Using all previous levels of the taxonomy, the student is able to derive a system for prescribing the necessary precedents and prerequisites for achieving a desired outcome.

The Williams and Haladyna system offers the teacher or test builder several options for test item construction. For example, one could choose the first three levels of the taxonomy. The high level, most difficult test items might require the students to explain why a given fact or event occurs, or identify and classify stimuli according to some underlying criteria (Illustration). The moderately difficult items could require the recognition of non-verbatim restatements of the information message or underlying topic (Summarization). The least difficult, lowest level test items might simply require verbatim recognition (Reiteration).

Clearly, there are numerous other ways one might utilize the Roid and Haladyna taxonomy in the DX system. These should be explored further by each interested test developer and made relevant to the specific topic and audience of the test.

Another extremely promising classification system for guiding item development is the Solo taxonomy (Collis & Briggs, 1979). This system was based specifically upon the logic of the successive levels in the

attainment of cognitive reasoning abilities described by developmental researchers (cf. Piaget & Collis, 1975). At each developmental level there are three possible response modes provided, which are easily translated into item types or difficulty levels (pg. 15-20):

1. Capacity involves the simple reflection of information, although not necessarily in perfect verbatim fashion. This involves the employment of the minimum number of pieces of information in order to respond.
2. Relating operation allows the student to identify an overall concept or principle which accounts for the information provided. This goes beyond the restatement or verbatim recall of the material. More sophisticated reasoning is required, and the student must be able to recognize or derive by induction some general conclusion concerning the information.
3. Consistency and closure. Here the respondent must justify the information in light of other facts known beyond the limited view of the message. This involves skills such as abstraction, juxtaposition, and other higher level, inferential cognitive capabilities. The student must be able to generalize the information beyond the setting given, yet not contradict either that specific information or other known phenomena.

The sample item set found in this manual uses a logic similar to the Solo taxonomy. Essentially, the lowest level items are restatements of the topical definition. Middle-level items could also be answered by a student

if the definition were known, but only if the student could "read between the lines" and recognize the underlying principles and elements operating in the definitional message. At the highest level there was simply not enough information in the definition alone to allow for correct responding. At this most difficult level the student had to go beyond and apply the information provided in the definition.

Once one becomes acquainted with the DX system, and after generating item sets, one will find no difficulty in becoming quite expert at following a three-level taxonomy philosophy. Soon you will be generating your own levels with success and encouraging results.

Section III

The Lattice

The DX interactive diagnostic testing package is based on a hierarchical lattice of eight multiple-choice items. Each topic to be tested is composed of a separate lattice of eight unique items. The lattice itself operates on a simple idea of three levels of difficulty based on the taxonomical arguments presented in the previous section. There are three response possibilities at each difficulty level. Figure 1 illustrates the complete lattice. Note that the informative definition is provided as a ninth lattice member.

This is how the DX system operates based on the lattice. (Follow Figure 1 while you read this. The consequences of correct answers are shown as solid lines; of incorrect answers, dashed lines.)

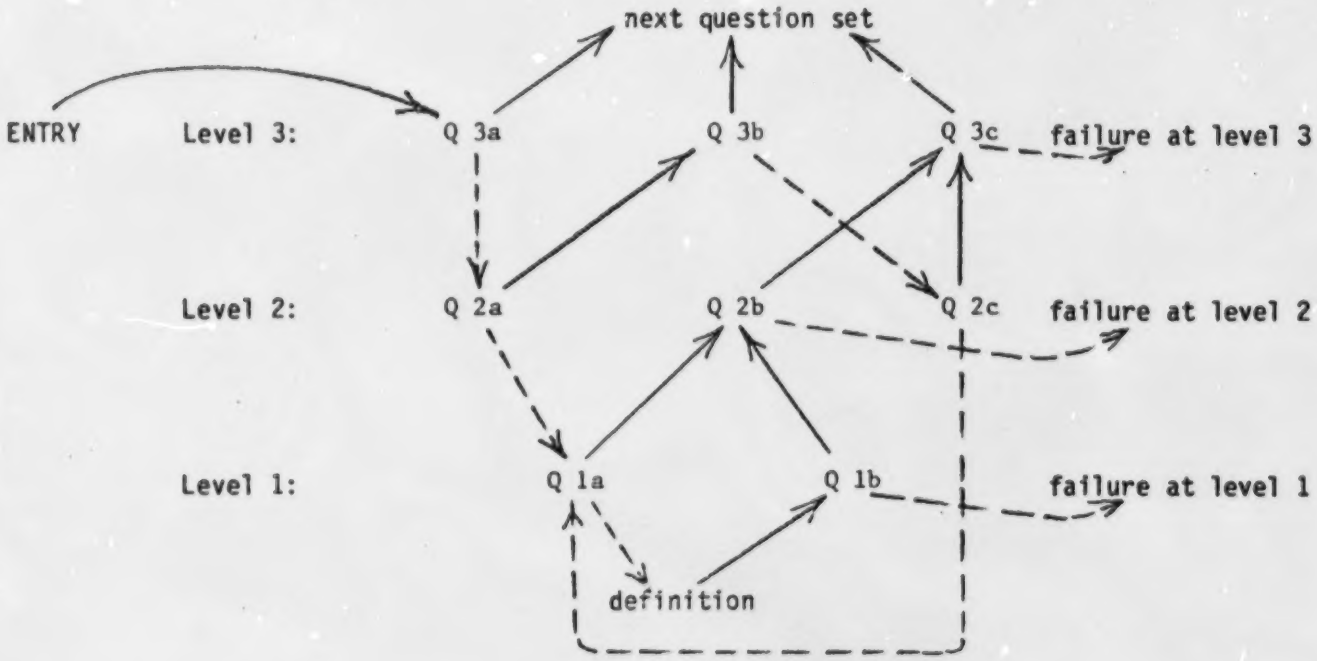
> The student is introduced to the first multiple-choice item in the topic being tested. The first item is at the highest, most difficult lattice level: level 3. If the student answers the initial question correctly, the computer interprets the performance to mean that the student knows the topic area and could answer all of the remaining items correctly if attempted. The computer then automatically introduces the student to the first item in the next topic lattice.
>
> If a student should fail the initial item, the computer informs the student of the correct response and then proceeds to the next level of the matrix. The second

response opportunity is the first item at level 2, the moderate-difficulty level. A correct response to this item offers the student a second attempt at the highest level. A failure at the middle level item sends the student to the lowest level of difficulty.

In the three-level lattice there are 18 discrete paths possible. Eleven response paths lead to failure at one difficulty level or another. Seven lead to a successful completion at the highest level, interpreted as success in the topic being tested. Each of the 18 paths clearly represents a different response pattern. Therefore, the computer is programmed to interpret each pattern uniquely and deliver a separate diagnostic interpretation.

Figure 1

A diagnostic item lattice for a question set comprised of three levels of difficulty. Solid lines show the paths taken after a correct response; dashed lines show the paths following an incorrect response.



Although any one student will only take one path, eighteen paths are possible:*

P -- next question set	level 3 correct on 1st try
F P P -- next	level 3 correct on 2nd try
F P F P P -- next	level 3 correct on 3rd try
F P F P F	dx: can't pass level 3
F P F F P P P -- next	level 3 correct despite trouble
F P F F P P F	dx: erratic; can't pass level 3
F P F F P F	dx: erratic; can't pass level 2
F P F F F Def P P P next	Level 3 correct w/ definition
F P F F F Def P P F	dx: can't pass level 3 w/ defntn
F P F F F Def P F	dx: can't pass level 2 w/ defntn
F P F F F Def F	dx: can't pass level 1 w/ defntn
F F P P P -- next	level 3 correct with prompt
F F P P F	dx: can't pass level 3 w/ prompt
F F P F	dx: can't pass level 2 w/ prompt
F F F Def P P P -- next	level 3 correct with definition
F F F Def P P F	dx: can't pass level 3 w/ defntn
F F F Def P F	dx: can't pass level 2 w/ defntn
F F F Def F	dx: can't pass level 1 w/ defntn

*P = pass; F = failure

Section IV

DX Subprograms

Within the DX package there are eight subprograms: Menu, Item File Writer, File Modifier, Hard Copy, DXOK, Question Index, Copy A, and Catalog. All are designed to preclude the need for any previous computer training or experience. They are self-prompting and generally operate by presenting the user with a series of questions and instructions which make their use simple.

The first subprogram is MENU. When one inserts the disk and turns on the computer, the screen will present a Menu of possible options for your use. Each of these options involves one or more separate subprograms. By selecting and entering the number associated with a desired Menu item, the computer will automatically oblige by presenting the requested subprogram.

The first Menu choice is for creating a question set. (This operation is accomplished by use of the Item File Writer program.) Briefly, this program allows the teacher to (1) give a title for a new question set, (2) enter the eight multple-choice items, along with (3) correct response properly designated and (4) the accompanying definition or informative passage.

An especially useful feature of the DX package is the option of selecting the number of alternatives offered with items. While all of the examples in this manual presume four-choice multiple-choice format, it is possible to have the following options:

a) or b)

a), b) or c)

a), b), c) or d)

a), b), c), d) or e)

t) or f)

How to select an option is shown on page (46). If none is selected, the program assumes four-choices.

The second Menu entry is available for modifying previously written question sets. File editing is accomplished through the File Modifier program. The program allows the teacher to view a file a line at a time or a page at a time. Changes in any line can be made by line deletion, line insertion, or line replacement. All necessary instructions are provided on the screen.

Third on the Menu list is a cataloging function. This allows the instructor to review the titles of all question files (and others) available on the disk. When a given student or group of students is to be tested on a certain unique topic collection, the instructor can peruse the available question sets in order to prepare the appropriate examination.

Selection number 4 on the Menu allows the instuctor to view (or print) any established question set. The program utilized for this function is called Hard Copy, and can be used with or without a printer available. Reproducing or viewing a file does not cause it to be altered or lost.

The fifth choice on the Menu is to run the test program. Selecting this alternative engages the testing format subprogram (DXOK) and automatically initiates the testing procedure. The student's name is requested, instructions are delivered, and the first multiple-choice item

is made available for response. The testing program also automatically stores and interprets the test performance, preparing the appropriate diagnostic readout.

The final Menu selection available is Quit. Choosing this alternative ends the DX package functions and returns the user to the Apple II computer. (Whatever was the last subprogram used, that's the program now in the computer's memory.)

One of the primary advantages to utilizing the DX testing system is its ability to create, store, and report diagnostic test results. In order to read these results, a separate subprogram within the DX package must be used: Hard Copy. This subprogram is available through Menu selection number 4. By typing in the student's name as a file title, this allows the teacher to view the results on the screen or to have them relayed to a printer if available.

Although not programs in the true sense, a comment needs to be made with reference to the Question Index and the item files. These are both integral, necessary elements of the DX package, and logically so. Certainly, the test package cannot run without first having directions from the Question Index on which topics are to be included in the test, and secondly, having test files available for use. Both types of files (Question Index or test files) are created by means of the Item File Writer and File Modifier programs (Menu #1 and #2) which will be reviewed in detail later in Section IV.

The final subprogram in DX is called COPY A. By means of this program an unlimited number of duplicates can be made of any existing DX test disk. You have already used this program to make a backup of the original

program disk, if you started at the beginning of this manual. Therefore, if you create a test package and want to use it in more than one computer at a time, then it can be reproduced. Also, teachers or test developers can share their DX test packages and their test files.

Section V

DX in Action: An Example

The following section is provided to acquaint the prospective DX user with the package by reviewing the package and its uses from the beginning. Employing a previously developed item set included on the DX disk, the reader will be led through the developmental and implementation phases of the DX system. Simply follow the narrative below and obey all instructions. (You will need an Apple II+ computer with a monitor [TV screen] and at least one disk drive to proceed through this section or any sections in this manual subsequent to this one.)

STEP 1: Computer Orientation

If you are already familiar with the use of the Apple II computer and the Applesoft language, you should first make a backup copy of the program disk. Store the original in a safe place. Then, go to "Step 2": Booting up the Disk".

If you are not familiar with the Apple II computer, you will find the next several pages very helpful. They are written to help you make every step of the procedure an easy one. If you find that you are having difficulty, go back and check the preceding steps to make sure all is well. Certain error messages are discussed at the end of this manual.

To begin, you should have an Apple II or Apple II+ with 48K of memory, a video monitor and one or two disk drives controlled by one controller card. This is your "hardware". A printer is handy but optional. No other hardware is required to execute the Diagnostic Testing System, nor is any additional software or programming language necessary. It is a stand-alone

interactive package. (Even if you have additional hardware, you should have no difficulty because the programs do not refer to extra devices.)

To make a backup copy of the program disk, which is your "software",

1) Insert the program disk into the #1 drive. (Do not let your fingers touch the shiny plastic surfaces which show through the slots--the natural human oils are sufficient to cause occasinal difficulties with the machine.)
2) Turn on the Apple II (via switch is on the rear left of the computer) and your video monitor. The disks will whir and you will see a MENU, which will be used later.
3) Type "6", then type "Y". You will see a "]", which is called the "cursor".
4) Type "RUN COPYA" and press "RETURN" and you will see

```
APPLE DISKETTE DUPLICATION PROGRAM

                    DEFAULT = 6  ORIGINAL  SLOT: 6
```

Press "RETURN" again and you will see

```
DEFAULT = 1        DRIVE: 1
```

Press "RETURN" another time and you will see

```
DEFAULT = 6    DUPLICATE  SLOT: 6
```

Press "RETURN" a fourth time and you will see

```
DEFAULT = 2        DRIVE: 2
```

If you have only one disk, type a "1". If you have two disks, press "RETURN" at this time, appropriate instructions will be given to you by the program. Your "original disk" is the program disk supplied with this manual; your "duplicate disk" is a fresh blank disk which will become the disk you will use from here on.

Before going any further, store the original program disk in a safe place, away from heat and moisture. (You may need to refer to it again if there's an unexpected system problem.)

Your best bet now is to turn off the Apple II and remove your "duplicate disk"--which for the remainder of this manual is referred to as the DX disk--and take time to read the following chapters and illustrations. The opening chapters will supply background information about the diagnostic testing procedure; the illustrations will show how the Diagnostic Testing System is implemented, from start to finish, while you run the program to see how it works.

STEP 2: Booting up the Disk

Again, if you are familiar with the computer, you may skip this part and go to "Step 3: The Menu". If you are new to computers, read this part carefully.

To begin, one must "boot-up" the computer disk. Booting up a disk is like priming a pump--it prepares the machine for its purpose. Booting is

accomplished by placing the DX disk into the disk drive, labelled side up, while holding it by the end with the label. (Some drives require that a closing mechanism of some sort be operated as part of the booting process.)

After the disk is securely placed in the drive, turn on the computer screen, then turn on the computer itself. As is explained in the Apple manuals, you will know when the booting process has been successful because you will hear whirring, mechanical sounds from your disk drive. Also, most drives have a light that indicates an operating state. Please, never remove or insert a disk into a drive that is still in the operating state. Severe damage may result.

STEP 3: The MENU

Type "RUN MENU" and then press "RETURN", and the computer screen will automatically print out the Menu for you. As described earlier, at this point you have several alternatives open to you. The screen lists them by showing you the following:

```
   WELCOME TO UCLA'S
    DIAGNOSTIC TEST PACKAGE
FROM THE CENTER FOR STUDY OF EVALUATION
   LOS ANGELES, CALIFORNIA
1:  CREATE A QUESTION SET
2:  EDIT AN EXISTING QUESTION SET
3:  LIST THE FILES ON THIS DISK
4:  LIST A FILE TO SCREEN OR PRINTER
5:  RUN THE DIAGNOSTIC PROGRAM
6:                 QUIT
....YOUR CHOICE?
```

To make your selection, simply punch the number key which corresponds to the choice you desire. For the sake of this narrated demonstration, just type the number 5.

When you make your selection you will be given the opportunity to change your mind, just in case you goofed. The screen will print:

...OK? (Y/N)

If your Menu choice was the one you really wanted, just punch the "Y" key, meaning "Yes". If you had goofed, or wanted to change your mind, punching the "N" key (meaning "No") would let you make a new Menu selection (try it).

Once "Y" is punched, the disk will whir again and the screen will tell you that the computer is in the process of complying with your Menu choice. In our case, the screen would say:

NOW LOADING THE PROGRAM TO
RUN THE DIAGNOSTIC PROGRAM

After a slight delay, the screen would advise you that the computer has been properly programmed by the disk to fulfill your Menu choice. In our example, the screen would inform you that the DX test program is loaded and ready to run:

WELCOME TO OUR
QUICK TEST IN SCIENCE...!
...PLEASE TYPE YOUR FIRST NAME AND YOUR LAST NAME...

The test package included with your DX demonstration disk covers science topics. Specifically, the example test that you will be taking is on the topic of "Photosynthesis". Don't be concerned if you know nothing about photosynthesis--the less you know the better this example will turn out. If you should know something on the topic, please follow instructions, not your intuition, thus aiding us in our training and familiarization phase.

As the screen expresses, the computer is now prepared to encode the examinee's name. It is important to remember two things at this point: First, the name typed in here will be used by the computer as a storage cue for the test results. For that reason, it does not really matter how a test-taker enters his or her name, so long as you are aware of the name being used. Later, the teacher uses the same name as the name for accessto that student's results. So, if an examinee types in gibberish, then the instructor will have trouble later when trying to get test outcome feedback.

Second, if the same name is used a second time with the identical disk, then the computer gets confused. The machine cannot imagine that two persons might have identical names, or that the same person might use this disk on two occasions. If the same name is used twice, the first performance for that name is replaced by the newest performance.

There are several ways to avoid this problem. First, one could add the date of the testing session after one's name, as long as there is only one session per date. Another idea is to use a different disk for each session. Also, one could number the test occasions by adding an appropriate chronological indicator after one's name. Generally, however,

this issue is not of any real concern, since the diagnostic readout of the test results is usually printed out or recorded soon after each test occasion.

After typing one's name, the next step is to push the "RETURN" key. This is one of the very few times that this is necessary. The "RETURN" key is found on the right-hand edge of the keyboard.

The next screen entry reads out as follows:

```
...I'M VERY PLEASED TO MEET YOU, PETER
   ...LET ME GET READY...
```

Notice that the computer addresses the examinee by first name only ("Peter" in the text example). The machine begins to whir again as it records the name and loads the first test in the programmed battery. Once the test is loaded, the computer gives the appropriate test-taking instructions:

```
I WILL ASK YOU A FEW SHORT
   QUESTIONS NOW ABOUT SCIENCE.

EACH OF THEM NEEDS JUST ONE ANSWER

WHEN YOU READ THE QUESTION,
  GIVE YOUR ANSWER BY TOUCHING

  A, OR  B, OR  C, OR  D


... IS THAT OK?

      A.  YES, THAT'S OK!

...NOW TYPE <A>
```

In this specific example set (photosynthesis), there are four alternative choices available with each item presented. The instructions clearly orient the student to the use of the four response keys; A, B, C, and D. If a test file were structured with more or less alternatives, then the instructions would reflect the choices available. The examinee verifies that the instructions have been read by pressing the "A" key.

NOTE: Due to the complexity of the DX program package, the Apple II computer often needs to be coaxed in order to accept a response. If a response key is punched and there is a "beep" sound as well as a screen change, then one should simply proceed. However, if there is no "beep" or screen change after a response is made, then the computer has not "understood" or accepted the choice made. Simply repunch the key until the computer responds. Caution your students about this; just tell students to press the key they choose until they hear the "beep".

Once "A" is punched, the test will begin.

STEP 4: The Test

Immediately, and with no topical cue or introduction, the screen presents the student with the first item in the first test topic lattice. Figure 2 illustrates the specific item lattice structure for the photosynthesis file. Note that the item you see on the screen matches the first test item, in the upper left-hand corner (Figure 2):

Figure 2

Lattice Structure of Items from
the DX Photosynthesis Subtest

Start
WHY ARE MAMALS INCAPABLE OF PHOTO-SYNTHESIS?
...A. THEY LACK CARBON DIOXIDE.
...B. THEY LACK LIGHT.
...C. THEY LACK CHLOROPHYL.
...D. THEY LACK ARYTHROBLASTS.
right
AN UPROOTED PLANT WILL QUICKLY DIE; EVEN IF IT IS UNDAMAGED. WHY?
...A. IT LACKS MINERALS NECESSARY FOR GROWTH.
...B. IT LACKS WATER FOR OXYGEN AND SUGAR PRODUCTION.
...C. IT LACKS OXYGEN NECESSARY FOR PHOTOSYNTHESIS.
...D. IT LACKS SOIL WITH WORMS FOR PROPER AERIFICATION.
right
A POTTED PLANT LOCKED INTO A CHAMBER WITH ONLY OXYGEN; WATER; AND LIGHT WILL SOON DIE. WHY?
...A. IT LACKS CARBON DIOXIDE FOR PHOTOSYNTHESIS.
...B. IT LACKS MICROORGANISMS FOR SOIL MINERAL REDUCTION.
...C. IT LACKS CHLOROPHYL BECAUSE THE CHAMBER IS LOCKED.
...D. IT LACKS SUGARS NEEDED FOR PHOTOSYNTHESIS.
right
next question set
failure at level 3
wrong
WHAT DO GREEN PLANTS RELEASE AS A PRODUCT OF PHOTOSYNTHESIS THAT HELPS ANIMALS LIVE?
...A. MINERAL DEPOSITS.
...B. CARBON DIOXIDE.
...C. PROTOZOIC ACIDS.
...D. OXYGEN
right
wrong
WHAT IS THE SOURCE OF THE ENERGY THAT GREEN PLANTS NEED FOR PHOTOSYNTHESIS?
...A. LIGHT.
...B. STATIC ELECTRICITY.
...C. SOIL MINERALS.
...D. CHLOROPHYL.
right
WHAT DO ANIMALS PRODUCE DURING RESPIRATION THAT HELPS PLANTS DURING PHOTOSYNTHESIS?
...A. NITROGEN.
...B. OXYGEN.
...C. CARBON DIOXIDE.
...D. TETRACHLORIC CHLOROPHYL.
wrong
failure at level 2
wrong
right
WHERE DO PLANTS GET THE CARBON THAT THEY NEED FOR PHOTOSYNTHESIS?
...A. CARBOHYDRATES IN THE SOIL.
...B. AMMONIA IN FERTILIZERS AND SOIL.
...C. WATER.
...D. CARBON DIOXIDE IN THE AIR.
right
AS A RESULT OF PHOTOSYNTHESIS; PLANTS PRODUCE --
...A. HEAT AND OXYGEN.
...B. SUGAR AND OXYGEN.
...C. NITROGEN AND OXYGEN.
...D. SUGAR AND NITROGEN.
failure at level 1
wrong
PHOTOSYNTHESIS IS THE PROCESS BY WHICH GREEN PLANTS SYNTHESIZE OR PRODUCE THE SUGAR THEY NEED FOR ENERGY. LIGHT; CARBON DIOXIDE; AND WATER COMBINE IN PLANT CELLS TO PRODUCE SUGAR AND OXYGEN.

```
WHY ARE MAMMALS INCAPABLE OF PHOTO-
SYNTHESIS?
...A.  THEY LACK CARBON DIOXIDE
...B.  THEY LACK LIGHT
...C.  THEY LACK CHLOROPHYL
...D.  THEY LACK ARYTHROBLASTS

  WHAT IS YOUR CHOICE
    (A, B, C, OR D) ?
```

Two comments are relevant at this point. First, the DX testing package is progammed to accept only A, B, C, or D as possible responses to this test file. If an examinee accidentally or intentionally presses any other key on the keyboard, the "What is your choice" question will be reprinted, including the four possible aternative key choices (try it!). Once again, the program is fool-proof.

Secondly, it is important to reiterate that a response key may have to be pressed a few times before it registers.

By consulting Figure 2 one can discern what will happen based on the response to this first item. If one gets it correct, then the item set is conquered and the first item of the next topic set will appear. If one fails the first attempt, then the first item at the second lattice level will appear.

For the sake of experience, it will be more instructive if you would please fail the first item. Therefore, PRESS "A". The "beep" is heard and the screen adds:

```
SORRY, BUT THE CORRECT ANSWER WAS C
```

This message will appear together with the test item failed for long enough to allow the examinee to reread the item and make the appropriate mental corrections.

Note that the DX system has another built in advantage over pencil-and-paper formats: Immediate feedback. This makes the examination both an assessment as well as a learning occasion.

After a short delay for the feedback, the screen presents the second test opportunity:

```
WHAT DO GREEN PLANTS RELEASE AS A
PRODUCT OF PHOTOSYNTHESIS THAT HELPS
ANIMALS LIVE?
...A.  MINERAL DEPOSITS.
...B.  CARBON DIOXIDE.
...C.  PROTOZOIC ACIDS.
...D.  OXYGEN

  WHAT IS YOUR CHOICE
    (A, B, C, OR D) ?
```

Recall that this is actually the first chance on the second, or middle lattice level (see Figure 2). Again, for the sake of illustration, please get this item wrong also. Please PRESS "C".

SORRY, BUT THE CORRECT ANSWER WAS D

Again, the feedback is immediate and lasts long enough to allow for encoding and self-correction.

The next item to appear is the first chance at the lowest difficulty level of the lattice (see Figure 2):

WHERE DO PLANTS GET THE CARBON THAT
THEY NEED FOR PHOTOSYNTHESIS?
...A. CARBOHYDRATES IN THE SOIL.
...B. AMMONIA IN FERTILIZERS AND
SOIL.
...C. WATER.
...D. CARBON DIOXIDE IN THE AIR.

WHAT IS YOUR CHOICE
(A, B, C, OR D) ?

Again, for the sake of instruction, please make the wrong response. Please PRESS "B".

SORRY, BUT THE CORRECT ANSWER WAS D

At this point, the examinee has failed to pass any item. However, to say that three errors have produced a score of 0 (zero) is to oversimplify the real diagnostic results. Actually, the student has failed to respond correctly to analogous content questions from most difficult to easiest. Obviously, the student need some instruction or refreshing. Therefore, with no further prodding the computer will provide a simple statement or definition to any examinee who fails at the easiest lattice level (see Figure 2):

```
PHOTOSYNTHESIS IS THE PROCESS BY
WHICH GREEN PLANTS SYNTHESIZE OR
PRODUCE THE SUGAR THEY NEED FOR
ENERGY.  LIGHT; CARBON DIOXIDE; AND
WATER COMBINE IN PLANT CELLS TO
PRODUCE SUGAR AND OXYGEN.

WHEN YOU ARE READY, TOUCH ANY KEY...
```

The test developer can place any information desired in the definition position in the test file. For this specific file, we chose a simple explanatory statement about photosynthesis. The examinee informs the computer that the definition has been encoded, and that s/he is prepared to resume testing, by pressing any key.

The next item to appear is the second chance at the easiest level:

```
AS A RESULT OF PHOTOSYNTHESIS; PLANTS
PRODUCE --
...A.  HEAT AND OXYGEN.
...B.  SUGAR AND OXYGEN.
...C.  NITROGEN AND OXYGEN.
...D.  SUGAR AND NITROGEN.

  WHAT IS YOUR CHOICE
    (A, B, C, OR D) ?
```

Based on the definition you read, you either learned the answer to this question, or your memory was refreshed. For the sake of our exercise, let's get this one RIGHT. Please PRESS "B".

THAT'S RIGHT: GOOD JOB!

Note that the screen now provides reinforcement as feedback. The praise remains for a brief time. Then, the second test on the middle level occurs (see Figure 2):

WHAT IS THE SOURCE OF THE ENERGY THAT
GREEN PLANTS NEED FOR PHOTOSYNTHESIS?
...A. LIGHT
...B. STATIC ELECTRICITY.
...C. SOIL MINERALS.
...D. CHLOROPHYL.

WHAT IS YOUR CHOICE
(A, B, C, OR D) ?

For the sake of our instruction, please goof again. Please PRESS "D".

SORRY, BUT THE CORRECT ANSWER WAS A

At this point our mythical examinee has failed a second time at level 2 of the lattice. The DX program interprets this to mean that further opportunities at any level above level 1 would not clarify the diagnosis of comprehension level, and so the topic set ends at this point. The student is simply told:

...OK, PETER ...

...HOLD ON FOR JUST A MOMENT, PLEASE...

While this message appears, the disk drive whirs as it loads the next test set. In our example there is no "next test set", and so the computer advises the student that the test session is over:

THANKS, PETER ....
I'VE ENJOYED WORKING WITH YOU TODAY...
...THAT'S ALL FOR NOW. SO LONG...!

This message will always appear after all test sets in the Question Index have been completed. It simply indicates to the student that s/he is free to leave.

STEP 5: Diagnostic Output

While the student has been taking the tests, the computer has been (1) recording the response patterns and (2) preparing the diagnostic interpretations. In our example test, the computer should have recorded one error at level 3 (highest level), two errors at level 2, and one error and one success at level 1 (the lowest level). Also, there should be a report made that we reached the definition.

In order to access and read the diagnostic output, one needs to return to the menu. After the farewell greeting which finalized the test occasion, the Apple II "cursor" appeared at the bottom of the screen. The cursor is a left-handed bracket which is flashing on the lower left side of the screen. To return to the menu, simply type RUN MENU. The screen will look like this:

]RUN MENU

Be sure to leave a space between the two words. Use no punctuation; that will only confuse DX. After typing that statement, press the "RETURN" key. Whirring will soon be followed by a reappearing of the Menu on the screen.

(Note: If an error message appears when you press the RETURN key, then simply retype RUN MENU a second time, being extra careful of spelling and spacing. Then press "RETURN". If that doesn't work, (1) turn the computer off by reaching in back on the left side, (2) wait a couple of seconds, and (3) turn it back on . The MENU will automatically appear.)

```
  WELCOME TO UCLA'S
    DIAGNOSTIC TEST PACKAGE
FROM THE CENTER FOR STUDY OF EVALUATION
    LOS ANGELES, CALIFORNIA
1:   CREATE A QUESTION SET
2:   EDIT AN EXISTING QUESTION SET
3:   LIST THE FILES ON THIS DISK
4:   LIST A FILE TO SCREEN OR PRINTER
5:   RUN THE DIAGNOSTIC PROGRAM
6:                    QUIT
....YOUR CHOICE?
```

This time we want the computer to produce the results of the test experience. These results are currently stored as a file named for the person tested. To access that or any diagnostic file, choose MENU item #4:

4

When asked to verify your choice, type "Y".

```
...OK?  (Y/N)
```

Remember to press the "RETURN" button (if nothing happens).

The screen will now advise you that it is getting the file reading program ready:

```
NOW LOADING THE PROGRAM TO .
LIST A FILE TO SCREEN OR PRINTER
```

When the computer is ready, it will ask you to supply the name of the file you want to read. Here, it is important to learn tow things. First, all files of tst results are ear-marked with the DX tag. So, for example, Pete's (Pete Matheson) test output would be stored as DXPETE MATHESON.

In other words, it is critical to know the name that the test taker used. Then, just add a "DX" to the front of the name WITHOUT A SPACE.

The screen looks like this when it wants you to name the file desired:

...EXAMINING NAME?

Touch no keys except those needed to type the file name. Once the file name is complete, press the "RETURN" key.

The computer will then ask whether you want the file results printed. If you say "no", then the screen will show you the file. If you say "yes", the screen and the printer (if available) will both produce the results.

DO YOU WANT PRINTED COPY? (Y/N)

If you get a message stating that the file you requested does not exist,

FILE NOT FOUND

several things could be wrong. First, you may have made a typographical error. Simply retype the correct file name (with "DX") and try again. If that fails, then there may be a discrepancy between the name used and your expectation. If this is possible, then there is no other recourse but to examine the list of file names.

This is done by pressing the "RESET" key. A cursor will appear. Now type: RUN MENU, followed by pressing the "RETURN" key. When the menu appears, make selection number 3.

3: LIST THE FILES ON THIS DISK

After you verify your choice, the screen will produce a catalog listing of all files on the disk you have booted up. Read the list in search of the appropriate file desired. Note that the list may be longer than just one page of the screen, so use the space bar to continue from one page of the catalog to the next.

When you spot the desired file, jot down the precise name. Then, press the "RESET" key. Type in RUN MENU, and proceed with option #4.

If you said "Y" (yes) to the request concerning printing, the screen will now remind you to turn the printer on:

...MAKE SURE YOUR PRINTER IS READY

Then, suddenly, the diagnostic printout appears. The first line repeats the file name (the examinee). The second line lists the title of the first subtest administered. The third line lists the response patern. The fourth line provides the diagnostic feedback. The three-line group of test name, response pattern, and diagnostic narrative will be provided for each test taker at a given occasion.

Your feedback, if you followed the response instructions, should look like this:

```
PHOTOSYNTHESIS
X..XX.XP.
PASSED AT LEVEL 1 AFTER REACHING
THE DEFINITION DIRECTLY AND THEN PASSING
AT LEVEL 1 BUT FAILING AT LEVEL 2

      # OF LINES IN FILE = 4
```

To interpret the response pattern, just remember that there are three possibilities at each lattice level. For each test item attempted, "X" reports a failure and "P" reports a success. Dots (.) designate items not encountered by the examinee.

In our case, divide the performance pattern into thirds by adding slashes:

X../XX./XP.

The first section corresponds to the three high-difficulty items. Only one was attempted (the first item given) and it was failed. The middle section corresponds to the three middle-difficulty items. Here the examinee had two chances, and failed both. Finally, the last section applies to the two low-difficulty items and the definition (always reported as a dot, whether seen or not). The pattern shows that the first try at this level was a failure, but the second was a success.

Note that the only way one can reach the second item at the lowest level is by first seeing the definition (see Figure 2). For that reason, no entry is made in the pattern indicating that the definition was reached.

To interpret the diagnostic readout, two things must be considered. First, the beginning of the narrative will designate the lattice level at which the test was passed. Also, if the definition is reached with successive failures at all three levels, then the pattern is reported as "reached the definition directly", or "by the most direct route". Second, the narrative is not topic specific, but is designed to be applied to any test utilized.

Summary

Take some time and run through the test a few times. Produce a different pattern each time--there are 18 in all. Be sure to change your name each time to avoid problems.

Section VI

Do It Yourself

Having experienced the trial runs in Section IV, you are now prepared to generate your own test file. This is accomplished in three simple steps.

STEP 1: Item Generation

Based on the logic of the lattice structure already discussed, choose a topic which can be easily adapted to three levels of difficulty. When you get more practice, any topic will work for you. For now, though, concentrate on an easy topic and obvious taxonomy.

Next, write out the central concept to be assessed and definition upon which all of the items will be based. Then, using the taxonomy you decided upon, generate eight items:

- o two most simple ,
- o three middle difficulty
- o three highest difficulty

Having designed the item with four alternatives each, you are prepared to create a new test file.

STEP 2: Test File Creation and Editing

Once the test items and definition have been generated, place the DX disk in the disk drive and turn on the machine. As usual, the Menu will automatically appear. For item file creation, we are interested in the first two Menu choices:

```
1:  CREATE A QUESTION SET
2:  EDIT AN EXISTING QUESTION SET
```

Following the same selection procedure we have used before in the Menu program, select option #1.

```
....YOUR CHOICE? 1
      ...OK? (Y/N)
```

Soon the computer will acknowledge your selection and ask you to name your new file. It's probably best to entitle it based on the topic covered, although any title you can recall will suffice.

After carefully typing the file title, press the "RETURN" key. The screen will fill up with instructions on how to properly use the FILE WRITER subprogram. After you read the instructions, begin typing the first, most difficult item. The actual sequence for entering the items is as follows:

HIGHEST LEVEL	1	2	3
MIDDLE LEVEL	4	5	6
LOWEST LEVEL		7	8
DEFINITION			9

<u>The items must be entered in that order for DX to work properly!</u>

There are a couple of limits helpful in using the FILE WRITER. If you want to indent, just place a period (.) at the beginning of the appropriate line and then you can space inward. If you just use the space bar without a period, the computer will ignore the indenting and print the items without it.

Also, if you should try to use commas, colons, or any punctuationother than periods or slashes, the computer will ignore them. (The reason for this is that the programming in DX is already complex. Increasing the complexity by programming for punctuation, underlining, or quotes will only decrease the program's efficiency and create potential malfunctions.)

The question mark (?) is the new cursor. Type the text one line at a time. If you have a sentence to type, limit it to 40 elements (spaces and letters) or less per line by using the "RETURN" key after each line. Too many letters per line will cause the computer to cut words in half when it runs the test, making it hard to read. Also, start each response alternative on a new line.

After each item is entered, along with its corresponding response alternatives, it is CRITICAL to indicate to DX which answer is correct. This is done by typing an asterisk, followed immediately by the letter of the correct answer.

A sample item, complete with all alternatives and the correct answer, might look like this:

```
?HOW OLD IS ALBERT?
?.    A. 13
?.    B. 19
?.    C. 35
?.    D. 188
?*C
```

Three more hints. Don't number your items. If placed in the proper sequence, the DX system will know what numbers they are. Don't use an "!" or an "*" in the first column except for the special purposes noted here. It will confuse your computer. Also, don't be concerned about small errors--you'll have a chance to correct them later.

After the last item, enter the definition by simply following the same 40-letter-line rule, as well as punctuation limitations Definitions should be kept as brief as possible--you have limited screen room (about 15 lines).

Once all items and the definition are typed out, end the file with a line of three asterisks (***), followed by a line with one exclamation point (!). This is critical because these two lines of punctuation marks are what indicate to the computer that you are through, and that a file ends at that point.

```
 1 HOW OLD WAS ALBERT?
 2 .    .A 15
 3 .    B. 19
 4 .    C. 35
 5 .    D. 188
 6 *C
 7 ....SEVEN MORE ITEMS....
 8 ...AND ONE DEFINITION STATEMENT.
 9 ***
10 !
```

After the exclamation point, press the "RETURN" key once more and the screen will ask:

WOULD YOU LIKE TO REVIEW ? Y

Typing "Y", followed by "RETURN", will cause the entire file to go by on the screen so that you can proof it. Note that the lines are now numbered for your convenience.

After the review is complete, the screen will ask:

...ANY CHANGES ?

The program called the FILE MODIFIER is a more extensive editing program. For that reason, we advise that you save the file, errors and all, by indicating that you do not need any change.

To the next two questions, tell the machine that you desire no more reviewing ("N"), but that you do want to save the file ("Y").

```
....DO YOU WANT TO REVIEW ONCE MORE ? N
...SHOULD THIS FILE BE PRESERVED?  Y
...NOW SAVING ALBERT ON DISK
...WOULD YOU LIKE PRINTED COPY? N
```

At this point, on the cue of the cursor, request the Menu again:

```
JRUN MENU
```

This time, select option #2 in order to edit the file you created. After verification ("Y"), the screen will print:

```
NOW LOADING THE PROGRAM TO
EDIT AN EXISTING QUESTION SET
```

When asked what name, type in the name you chose when you created the file. Then, press "RETURN".

```
...WE ARE MODIFYING
      AN EXISTING FILE...

....NAMED WHAT ?
...ON WHICH DISK   <1> OR <2> ?
```

When asked which disk drive is being used, generally #1 is the answer. The next messages alert you that the file is being (1) loaded and (2) duplicated. The duplication process (back-up) makes it impossible to lose the file completely, even if you should goof during editing.

```
NOW INPUTTING...
NOW MAKING A BACKUP COPY
```

The text of the file will appear 20 lines at a time. If you want to make any changes, simply type "Y", press "RETURN", and then the line number, press "RETURN". The computer then produces a list of editing instructions which involves three options:

```
WHICH LINE # ?

IF YOU LIKE THE LINE, HIT <SPACE>

IF YOU WANT TO REPLACE, TYPE <R>
   THEN TYPE THE NEW LINE...

IF YOU WANT TO DELETE THE LINE, TYPE <D>
```

At the bottom of the screen, the erroneous line is reprinted, and the question mark (?) cursor appears. Indicate the letter for the editing function desired (R, I, or D), press "RETURN", and follow the appropriate instructions. For "D", the line will automatically disappear. For "R", you will need to retype the whole line. For "I", the computer will allow you to insert a line of text ABOVE the line number you told it to change. If you decide not to change the line at all, press the space bar and no change will be made.

If no changes are desired for the lines being viewed, then type "N" for "any changes?", and press "RETURN"--the next 20 lines will be listed.

In this manner one eventually reaches the end of the file. At this point a new set of questions appear one at a time:

...ANY CHANGES ?

"Y" sends the entire process back to the first item again. "N" brings the next question:

...DO YOU DESIRE TO ADD LINES ?

"Y" produces the cursor (?) and allows you to add new lines to your file. "N" produces the next inquiry:

....SHALL WE PRESERVE THIS FILE? Y

"N" returns to the first of these three questions. (If you are thoroughly displeased with the editing you have done, don't try to go back to edit your editing. Instead, press "RESET" and return to the MENU, select option #2, and bgin again as described at the middle of page 42.) Remember, however, that the back-up copy still exists. (Consult the catalog--Menu option #3.) "Y" produces this output:

```
YOU NEED TO CHOOSE:
 <R> FOR REPLACEMENT OF CURRENT FILE
 <N> FOR NEW FILE INSTEAD
```

Since you are editing an existing file, type "R", and press "RETURN". This will cause the new edited version to replace the old version which had the errors.

STEP 3: Question Index

The computer administers the files that are placed in the Question Index. In order to test your new file, you need to register it in the Question Index file. To do this, you simply use the FILE MODIFIER subprogram.

Either turn the machine on anew, or type RUN MENU after the cursor. When the menu appears, select option #2. Verify your choice ("Y").

When asked to name the file desired, type QUESTION INDEX, then press "RETURN". When the file appears, it will read as follows:

1. Photosynthesis
2. !

When asked whether you want to make any changes, you have two choices. First, you may want to simply add your file to the test set. In that case, "I" is the best choice. By inserting your file above line #1, it will appear first in a two-test exam. By inserting it above line #2, it will appear second in the exam.

The second alternative is to remove Photosynthesis and put your file alone in its place. This best achieved with the "R" option. Simply say that you want changes ("Y"), in the first line ("1"), and then replace that line with the "R" command. When the cursor (?) appears, type in your test's title. The new Question Index will appear with the change.

Note that removing Photosynthesis or any test file from the Question Index does not erase or destroy the file. It can be replaced later if desired.

Make sure that the last line of Question Index is still an exclamation point (!). Without that, the DX system will not work.

After these changes, follow the same file preservation procedure you used after editing your test file. Be sure not to rename the Question Index.

The DX system is now ready to run. Enjoy your new test file.

NOTE: An Option for Number of Multiple-Choice Alternatives

The program assumes that the multiple-choice test uses form items. But you can tell it differently if you need to. In the QUESTION INDEX, the last line is "!". If you desire to have any of the following combinations, use the matching code instead.

Need		Use
Two choices	a) or b)	"!2"
Three choices	a), b), or c)	"!3"
Five choices	a), b), c), d), or e)	"!5"
True-false		"!T"

You can also turn off the feedback which informs the student whether a given response is correct or incorrect, if you desire. Merely add the letter "N" to the end of the lines above. "!2N" would mean "a) or b)" without feedback.

Summary

You can now construct tests which consist of any series of topic subtests that you have store. By restructuring the Question Index, you control the question sets that will be used and the order in which they will appear. Tests can be geared to individual or group needs and restructured at any time. Remember, the DX feedback automatically reports the exact topic titles which a student has been tested on, so you don't need to remember old Question Index contents.

Section VII

Diagnostic Feedback

The DX testing program automatically produces three types of feedback as a result of each test participation experience. In Section IV, Step 4, the procedure for obtaining a printed version of the feedback was reviewed. Also, that narrative outlined the nature of the three-facetted feedback output. This section of the manual explains some of the interpretations associated with the possible test-performance paths, as well as some brief comments on scoring procedures applicable to the DX feedback.

Feedback Interpretation

As was explained earlier in the manual (Section V, Step 5), there are 18 different paths possible in the eight item lattice used in the DX system (see Figure 1). Of those paths, ten are completed without the student ever reaching the definition. Interpreting results from these ten non-definition routes is rather straight-forward; all performances are based on knowledge attained prior to the test experience, and the results are a good indication of the level and depth of the student's unprompted comprehension.

An interesting issue arises, however, when a student follows an error path which provides the definition. Basically, if the examinee continues the test after encountering the definition, then it is difficult to interpret the results.

For example, if a student had no prior knowledge of a given topic, but was an excellent reader, then reading the definition might be sufficient

for immediately answering questions. Subsequent passing or failing of items is not necessarily an indication of long term knowledge or classroom learning of the material, but rather it becomes a reflection of reading ability and short term recall. That interpretation is not readily available through DX.

The only real answer to this potential problem lies with the teacher or feedback interpreter. As is true with any test results, no single score performance should ever be interpreted in isolation (Popham. 1981). Check relevant results from other tests. Compare reading scores. Also, compare scores on similar topics involving other item sets or contrasting definition statements. Finally, retest the student. If the concepts are truly mastered, then the performance on subsequent testings or related materials will reflect similar patterns.

Another potential danger in the feedback stems from the nature of the DX system. In order to make it easier to assess a series of topics, each separate test experience was designed to identify students who definitely know the material with minimal time expenditures. Repeated item trials for such pupils would only waste time and increase the probability of chance errors. For these reasons, a correct response to the first item is interpreted as mastery. The problem is that there is a chance that a naive or non-mastery student may get the first item right by just guessing! This would produce completely misleading output.

There are a couple of easy steps which can be taken to reduce the probability of that occurence. First. use as many distractor alternatives as possible in your test items. The more sound alternatives to choose from, the less the chance of guessing correctly. Secondly, be sure to put

the most challenging item as the first in the lattice, thereby providing a second fail-safe against guessing.

Scoring Procedures

The different types of feedback generated by DX offer a variety of scoring possibilities. The most obvious is the traditional "number correct", computed by adding up the number of "P" (correct response, or "Pass") scores from the feedback. This is, however, a potentially misleading score, because a student who knows the material well will only get one chance to even score correctly before bouncing out of the lattice. Meanwhile, a student unacquainted with the topic will have more opportunities to score correctly and to obtain a higher total score.

A better scoring method would be to report how many items a given examinee got right out of those s/he had the opportunity to answer. In statistical jargon, this is the proportion correct, or in simple language, percent correct. To calculate this, first count how many items in the set the student was allowed to answer, whether s/he got them right or wrong. Next, count how many s/he got right. Form a fraction by placing the number of right answers over the total number of attempts. Perform the division and you'll get a proportion, which is a decimal between zero (0) and positive one (+1 00). Then, just slide the decimal point to the right two spaces, and now you have the percent correct.

For example, imagine Barbara took a history test on the DX. Her SCORE pattern from the diagnostic readout looked like this:

XXPPPXP.

In this pattern, Barbara got seven chances to answer. She got four right. Her proportion score, then is:

$$\frac{4}{7} = .5714$$

Moving the decimal, her percentage score becomes:

57.14%

Another useful scoring procedure involves identifying and reporting the number corresponding to the lattice level at which a student passed. So, for example, a student scoring at level 3 would be higher than one at level 2. One could add up the levels across all subtests and get a composite score of sorts, or take an overall average across the subtest.

Section VIII

Conclusion

Repeated experiments have shown the DX system to be reliable and useful at all levels of school testing. The feedback has been especially exciting for classroom teachers who have used the package. Students have been more positive about the prospect of being tested by computers than by pencil-and-paper measures.

Again we add that DX is not a panacea for the testing world. If used correctly, however, the DX philosophy and accompanying software promise to improve testing in classrooms and provide comprehensive feedback for teachers and administrators.